Research Note 85-7

MARKSMANSHIP/GUNNERY CRITERIA: THE INFLUENCE OF TERRAIN-RELATED FACTORS, LINE-OF-SIGHT SEGMENTS, TARGET SELECTION, RANGE ESTIMATION, AND EVASIVE TACTICS ON TOW/DRAGON GUNNERY PROFICIENCY

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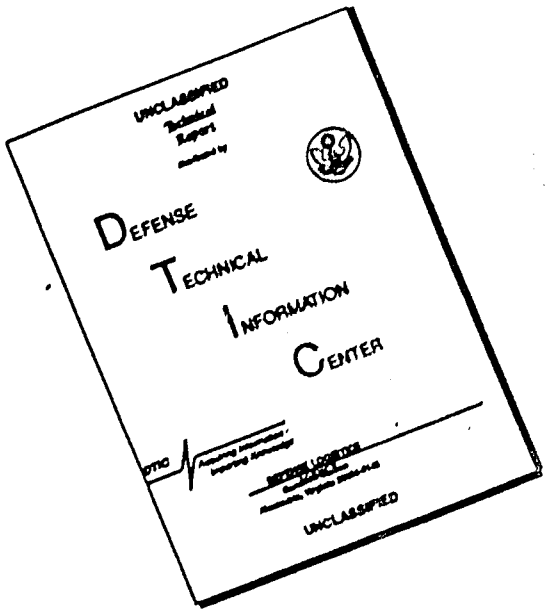

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Target engagement training for the TOW and Dragon weapon systems currently emphasizes tracking skills using the Launch Effects Trainer (LET). Gunners gain proficiency by tracking targets which are in the open and moving through the weapon system's area of responsibility. Factors other than the ability to track targets are required to employ the system effectively in combat. Current training programs do not emphasize specific combat tasks such as range estimation and selection of targets and line-of-sight segments. Since the learning process for sharpening these skills is not part of the current training program, there is a

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20. ABSTRACT (continued)

gap between skills emphasized in training and skills required in combat. This report attempts to reconcile this gap by developing a set of recommendations designed to heighten the degree of realism in the program of instruction.

FOREWORD

This report is one of a series on the research support provided by the Mellonics Systems Development Division of Litton Systems, Inc., to the Army Research Institute for the Behavioral and Social Sciences (ARI) under Contract Number DAHC 19-77-C-0011. This report, as submitted, is a part of the final report of the total contractual effort; it will be incorporated into that report by reference.

As set forth in the Contract Statement of Work, the Mellonics effort includes support to the Training Effectiveness Analyses (TEA) program, an effort focusing on three weapon systems: M16A1 Rifle, TOW, and Dragon. The report for the M16A1 Rifle has been completed and published under the title: MARKSMANSHIP/GUNNERY CRITERIA, Task A-2, Part One: M16A1 Rifle. It presents an analysis of factors affecting the development of threat oriented small arms training facilities. This current report for the TOW and Dragon Weapon Systems evaluates specific combat referenced marksmanship/gunnery criteria related to the tasks of estimating target distance and selecting targets, the impact of terrain and target evasive action on weapon performance, and the problem of achieving sufficient line-of-sight segments for successful engagements.

ABSTRACT

The training process can be subdivided into three distinct but interrelated areas: learning, retention, and transfer. In the design of training programs and in the use of training devices, transfer is a key element. It refers to the amount of learning which takes place during training on the simulator that subsequently influences performance on the parent system in the operational environment. Target engagement training for the TOW and Dragon weapon systems currently consists of practice tracking with the weapons with success being measured by the M-70 and the Launch Effects Trainer (LET), respectively. Gunners gain proficiency by tracking vehicular targets which are in the open and are moving through the weapon system's area of responsibility. The tracking skills acquired during training are presumably transferable to the parent weapon system.

The problem is that factors other than the ability to track are required to employ the weapon system effectively in combat. Current training programs do not emphasize specific combat tasks in which proficiency is necessary for success in combat. These combat tasks can be related to the influence of terrain on the gunner's decision-making processes immediately prior to firing the weapon. The decisions the gunner must make include: Which target is the greatest (or least) threat in view of my mission? Should I or should I not engage? Is the target within or out of range? Where on the probable approach path will there be a line-of-sight (LOS) segment of sufficient length to permit tracking? Can I compensate for possible evasive action and where are such actions likely to be implemented by the target crew?

Training for sharpening these skills is not a part of the current program. Consequently, there is a training gap in that these skills required in combat are not trained. This report provides recommendations to reduce this gap by increasing the realism of the training task requirements with respect to terrain selection (target path mapping, distribution of line-of-sight segments), target selection, range estimation, and evasive tactics. Thus, this report is an attempt to present methods for threat-oriented, combat-realistic ATGM training to meet the needs of the modern battlefield.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
Background	2
Objective	3
Method	3
ANALYSIS	5
Terrain-Related Factors	5
Line-of-Sight Segments	11
Target Selection	15
Range Estimation	16
Evasive Tactics	18
Concluding Comments	20
SUMMARY AND RECOMMENDATIONS	21
REFERENCES	24
FIGURES	
Figure 1. Distribution of angles from previous targets for subsequent engagements.by TOW gunners.	6
2. Distribution of angles from previous targets for subsequent engagements by Dragon gunners.	7
3. Distribution of engagement ranges for TOW from TETAM data.	9
4. Distribution of ranges for Dragon engagement from TETAM data.	10

TABLE OF CONTENTS (Cont'd)

Page

FIGURES

5. The probability that a threat vehicle will be engaged by TOW as a function of segment length (initial engagements only). 13

6. Segment length occurrence distributions for HLMR intervisibility data for ranges from 1000 to 2000 meters. 14

7. Dragon range card. 19

MARKSMANSHIP/GUNNERY CRITERIA - TASK A-2, PART TWO: THE INFLUENCE OF TERRAIN-RELATED FACTORS, LINE-OF-SIGHT SEGMENTS, TARGET SELECTION, RANGE ESTIMATION, AND EVASIVE TACTICS ON TOW/DRAGON GUNNER PROFICIENCY

INTRODUCTION

This is the second of two reports concerning marksmanship/gunnery criteria for the M16A1 Rifle and the TOW and Dragon Weapon Systems, prepared by the Mellonics Systems Development Division of Litton Systems, Inc., for the Army Research Institute for the Behavioral and Social Sciences (ARI), as a part of the Training Effectiveness Analyses (TEA) program of research under Contract Number DAHC 19-77-C-0011. The first report[1] addressed factors which should be considered in the development of a threat-oriented training program for the M16A1 Rifle. This one complements the first relative to the TOW and Dragon Weapon Systems.

The analysis of factors affecting the development of threat-oriented training programs for the TOW and Dragon is an ongoing effort at both the ARI and the U. S. Army Infantry School (USAIS). For these two agencies, under a contract separate from the above, Mellonics prepared two other major reports:

> Swezey, R. W., Chitwood, T. E., Jr., Easley, D. L., Waite, B. J. Implications for TOW gunnery training development (Final report, contract number DAAG 39-77-C-0044). Springfield, Virginia: Mellonics Systems Development Division of Litton Systems, Inc., October 1977.
>
> Swezey, R. W., Chitwood, T. E., Jr., Easley, D. L., Waite, B. J. Implications for Dragon gunnery training development (Final report, contract number DAAG 39-77-C-0047). Springfield, Virginia: Mellonics Systems Development Division of Litton Systems, Inc., November 1977.

The current report for the TOW and Dragon, in addition to complementing the M16A1 Rifle report, is designed to supplement the above two reports which provide findings from the available literature re factors associated with gunner tracking proficiency. Specifically, the above reports recommend that new TOW and Dragon Programs of Instruction (POI) should provide:

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[1] Klein, R. D. and Tierney, T. J., Jr. Analysis of factors affecting the development of threat oriented small arms training facilities (Task A-2 report - M16A1 rifle, contract number DAHC 19-77-C-0011). Fort Benning, Georgia: Mellonics Systems Development Division of Litton Systems, Inc., August 1977.

Variable Terrain Features.

Manipulation of Target Intervisibilities.

Variable Target Types.

Variable Engagement Ranges.

Variable Target Speeds and Maneuvers.

This report examines techniques and procedures for including improvements in the TOW/Dragon POI and develops corresponding measures of gunner performance under more nearly relevant tactical conditions.

BACKGROUND

Military trainers have long recognized the need to include tactical realism in training programs of instruction (POI) but are constrained by economic, technical, and safety factors. These constraints have a particularly serious impact on antitank (AT) weapon systems. These weapon systems are extremely costly, require expensive target instrumentation for training, and present safety hazards for both the trainer and trainee if used improperly. Consequently, compared to rifle training, training for antitank guided missile (ATGM) systems is accomplished in a more nearly controlled environment. This is particularly true during the sequence of events immediately prior to the killing of the target: acquisition and identification, estimating range, laying the weapon, deciding to fire, and guiding the missile to the target. Currently, weapon proficiency training focuses on the simplistic set of events of tracking a single target under ideal firing conditions. Crews/gunners are judged on their ability to maintain a consistent track during missile flights under these conditions. Since this is a pass/fail or performance criterion, training itself focuses on tracking, ignoring other job aspects. Thus, crews which are proficient according to accepted performance criteria may be seriously deficient in overall combat proficiency.

The combat tasks not included in the current POI are those associated with locating and identifying targets, establishing a priority of engagement, estimating ranges and selecting line-of-sight segments along probable target paths of sufficient length to permit successful engagements. The difference between skills required in combat and those emphasized in training leads to a

training gap.[2] The purpose of this analysis is to review current training procedures for TOW and Dragon systems to contrast these procedures with specific characteristics of the combat environment. Thus, this is an effort to define procedures and recommendations which can improve the degree of relevance or realism within the POI.

OBJECTIVE

The major objective of this analysis is the development of recommendations for TOW/Dragon POI revision to incorporate specific variables necessary to development of gunner proficiency in combat. The analysis concentrates on a current weakness: the lack of training on critical combat tasks required of the gunner/crew just prior to firing the weapon, and tracking targets as related to:

- Effects of Terrain;
- Line-of-Sight Segments;
- Target Priority Determination;
- Target Distance Estimation;
- Reaction Target Evasive Tactics.

METHOD

A review of the literature describing terrain studies, wargames, simulations, combat scenarios, and operational field tests was made to develop a usable concept of a potential mid-intensity conflict. In this context, five topic areas, shown above, are examined in detail. For instance, the analysis of line-of-sight (LOS) segments entails a detailed examination of factors which influence the time a target is in view of the ATGM position. These factors include the degree of cover and concealment available along the target approach path, the angle of approach, the amount of obscuration from

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2 U. S. Army Training and Doctrine Command. Training and Doctrine Command pamphlet 71-8: Analyzing training effectiveness. Fort Monroe, Virginia: Author, December 1975.

smoke and dust, target behavior, etc. This methodology is repeated for each of the five topic areas.

From these detailed descriptions, standards were derived against which techniques and procedures for increasing the degree of combat reference in training programs can be assessed. Those techniques and procedures which appeared to be practical and have utility value for the training environment are compared to similar procedures currently being used in operational testing.[3] It is maintained that these operational tests represent an acceptable trade-off between the relatively sterile training environment and combat. In designing operational tests, armor characteristics and user doctrine have been studied in order to incorporate realism consistent with acceptable test methodology. A review of design, test procedures, and supporting rationale provides the basis for incorporating similar methodology into TOW and Dragon training recommendations. Those techniques and procedures which appear to be applicable to the enhancement of the training environment appear as recommendations from this study.

The remainder of this report is divided into the two major sections of analysis and recommendations. The analysis section treats terrain-related factors, line-of-sight segments, target selection, range estimation, and evasive tactics. Each of these subsections is concluded with a set of findings and recommendations. The second major section is a summary of the recommendations.

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[3] Tactical Effectiveness of Tank Antitank Missile Systems (TETAMS) conducted by the U. S. Army Combat Developments Experimentation Command.

ANALYSIS

TERRAIN-RELATED FACTORS

In current TOW and Dragon gunner training programs, the influence of terrain is effectively eliminated. The extremely long maximum effective range of ATGMs requires at least 3.5km of relatively open space. Further, ATGMs often share firing ranges (facilities) with conventional AT weapons which require a large safety fan. As a result, ATGM facilities tend to be broad expanses of open land on which much realism is lost in training. For example, the target is in full view prior to start up; it moves laterally across the terrain at a fixed cross-over range from the firing position and at a fixed speed, and halts in full view. In combat, multiple targets come into view at different ranges, move at different angles and at varying speeds, are intermittantly visible, and can return fire. All except the last valriable are functions of terrain. The discussion in this section is limited to initial target ranges and angles of fire; LOS segments and target speed, although related directly to terrain type, are sufficiently important to be examined separately in the following section.

The literature contains much information on terrain characteristics. There are more than a dozen reported studies in which measurements have been taken to categorize and characterize typical terrain on which armor engagements might be expected in the event of war. Probably the most applicable is from an extended analysis of the TETAM data.[4] Intervisibility data were collected from 36 European and 12 U. S. sites (twelve sites in the Federal Republic of Germany (FRG) as well as from Hunter-Liggett Military Reservation (HLMR), California, and Fort Lewis, Washington). Using these data in a two sided computer simulation, it was found that the results of the battle were highly dependent on terrain characteristics and the selection of ATGM sites, and that the line-of-sight segments are typically shorter in the Federal Republic of Germany than on sites at Hunter-Liggett and Fort Lewis military reservations.

Figures 1 and 2 show distributions of firing angles for TOW and Dragon engagements respectively as gunners shift from previously engaged targets to new targets. One-half of the new targets for the TOW are within 10 degrees

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4 Clark, D. B., Sargent, J. D., Weaver, W. B., Marchi, R. P., and Vanarsdall, D. TETAM extended analysis (Final report - Volume I). Fort Leavenworth, Kansas: U. S. Army Combined Arms Research and Analysis Facility, December 1974. (AD-B003 157L)

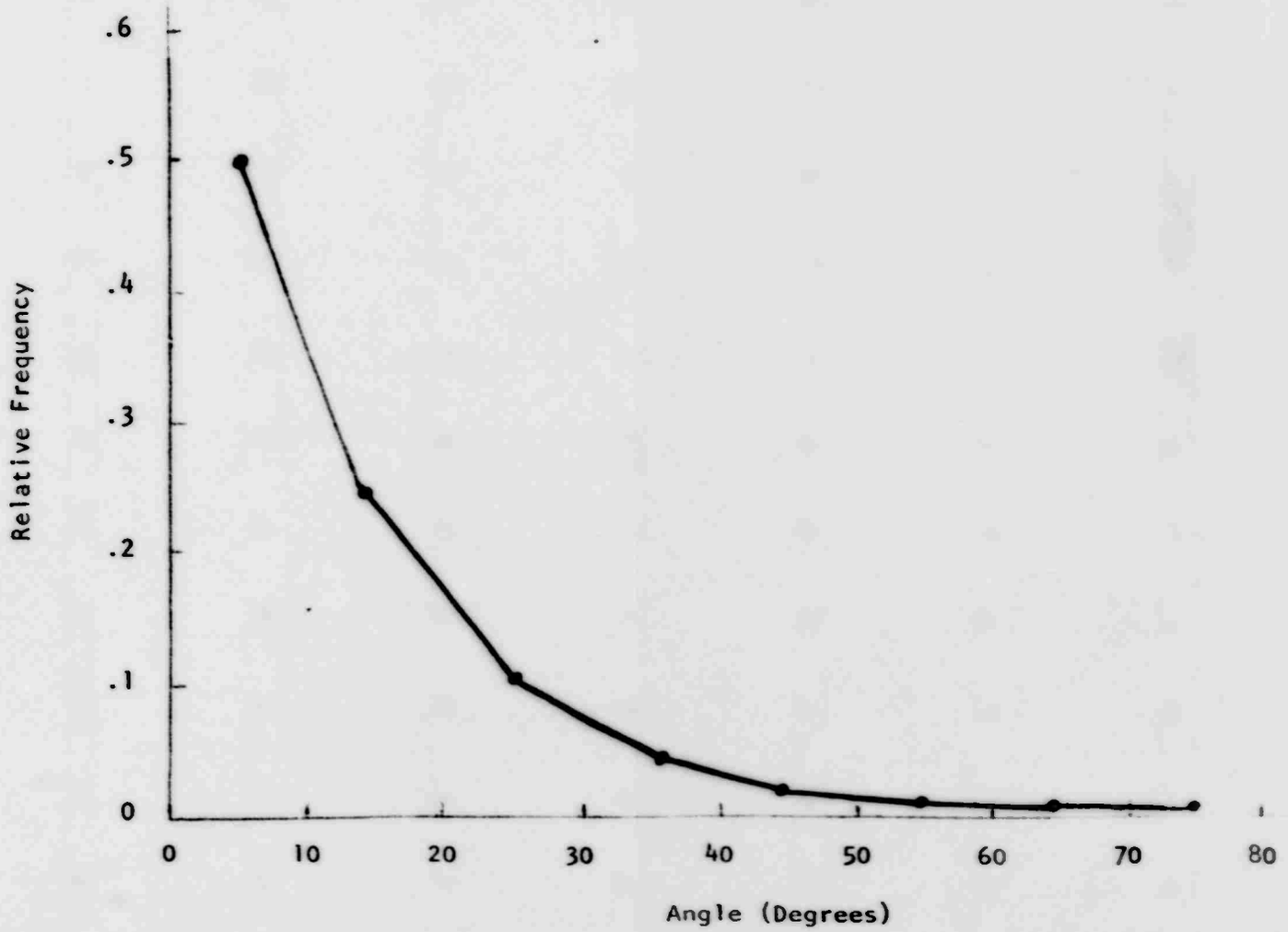

Figure 1. Distribution of angles from previous targets for subsequent engagements by TOW gunners.

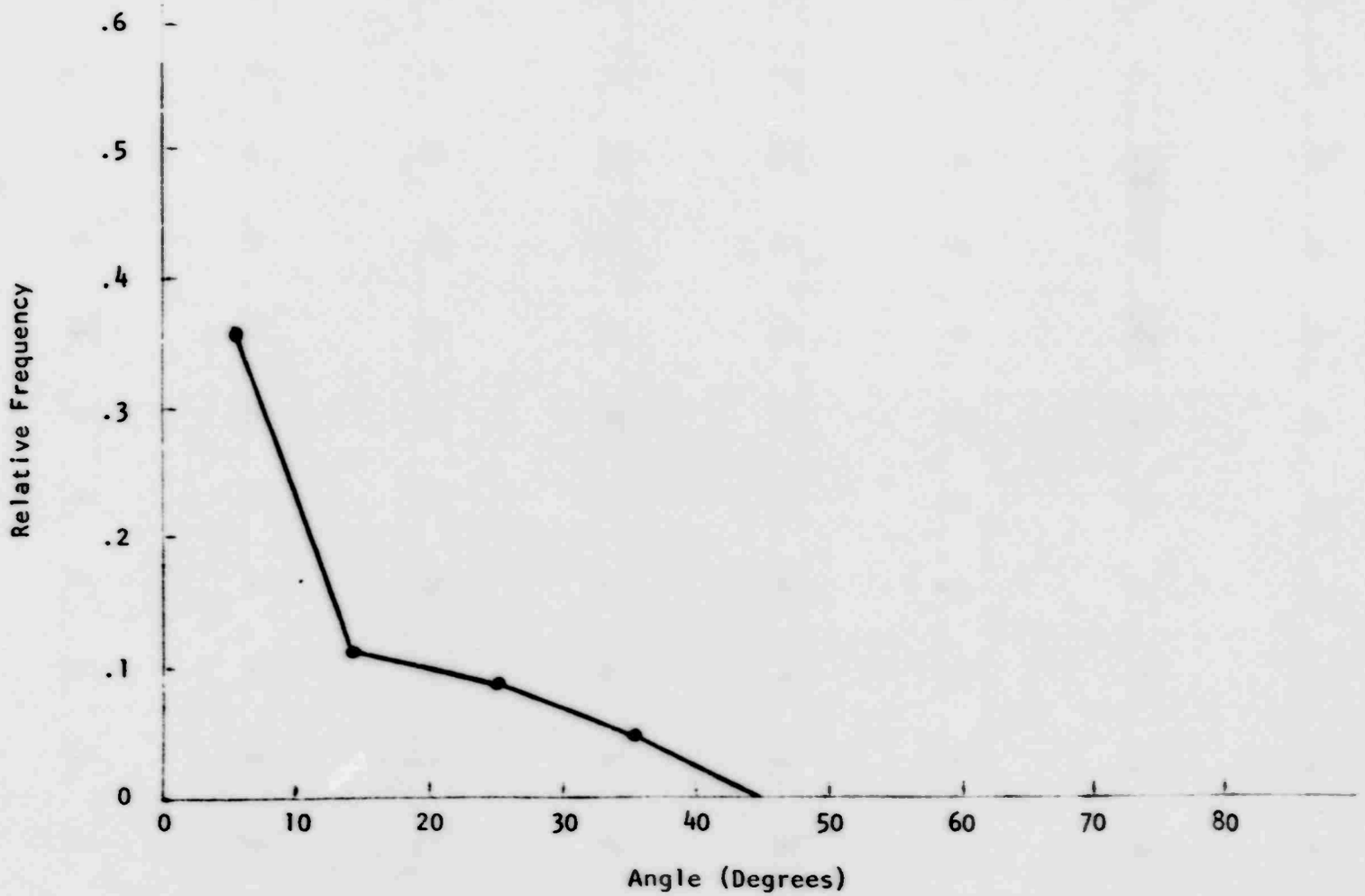

Figure 2. Distribution of angles from previous targets for subsequent engagements by Dragon gunners.

of the previous target; very few are acquired more than 30 degrees from the previous target. Similar results occurred for Dragon. Figures 3 and 4 show the distribution of targets in terms of range or firing distance. The great majority of targets appear between 1500 and 3000 meters for the TOW and from 0 to 1500 meters for the Dragon. For the TOW, the mean value for range to targets is 2000 meters with 70% of the targets appearing from 1500 to 2500 meters. Note that this distribution is based on the spread of the threat force and not on gunner selection, which was found to be range independent. The mean engagement range for the Dragon is approximately 800 meters.

Other terrain-dependent statistics available from field studies and terrain analyses are times to acquire targets and times between engagements. The mean values for target acquisition are:

TOW	92.8 seconds
Dragon	123.3 seconds

These data were collected during TETAMS conducted on HLMR terrain. From the data there appear to be no consistent relationships between acquisition time and engagement ranges. The data are from 2591 observations.[5]

Similar data on time between engagements are also available from TETAMS:

TOW	87 seconds
Dragon	93 seconds

These data may be useful in establishing performance criteria for trainee evaluation. Actual pass/fail criteria must be established as a function of the terrain used in any given training program.

These findings are substantiated by another study which examined the distribution of potential targets to all antitank weapons. Concentrating on high priorty targets only, the authors found that 50% of the potential targets occurred within 1400 meters and 95% occurred within 2600 meters.[6] Under conditions of limited visibility (smoke, darkness), there was an

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5 ibid.

6 Barfoot, C. B., Woodall, H. M., Jr., Helmbold, R. L., and Wallace, D. B. Analysis of factors which influence tank-antitank engagement ranges (CORG memorandum). Washington, D. C.: Combat Operations Research Group, 28 February 1962.

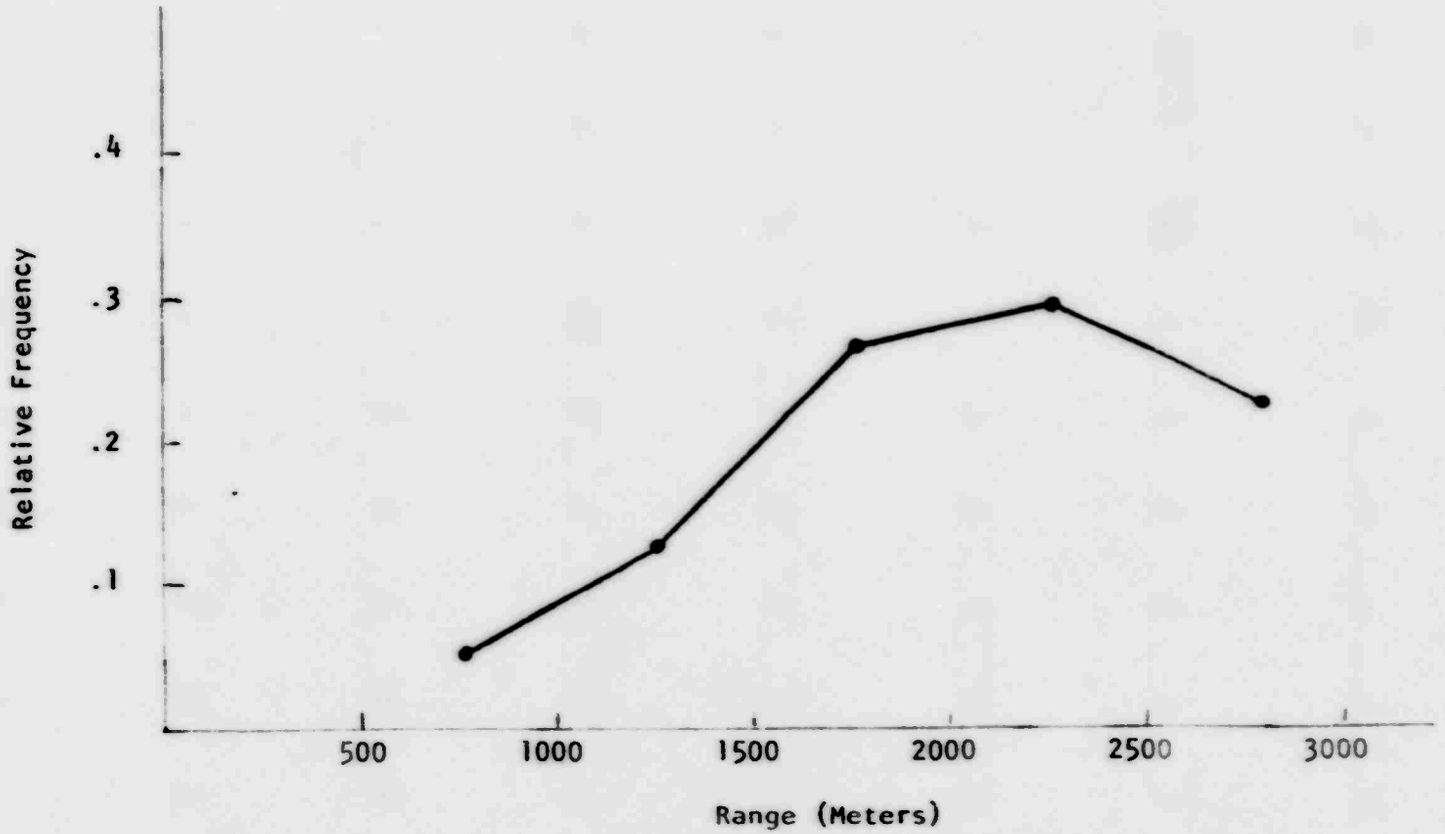

Figure 3. Distribution of engagement ranges for TOW from TETAM data.

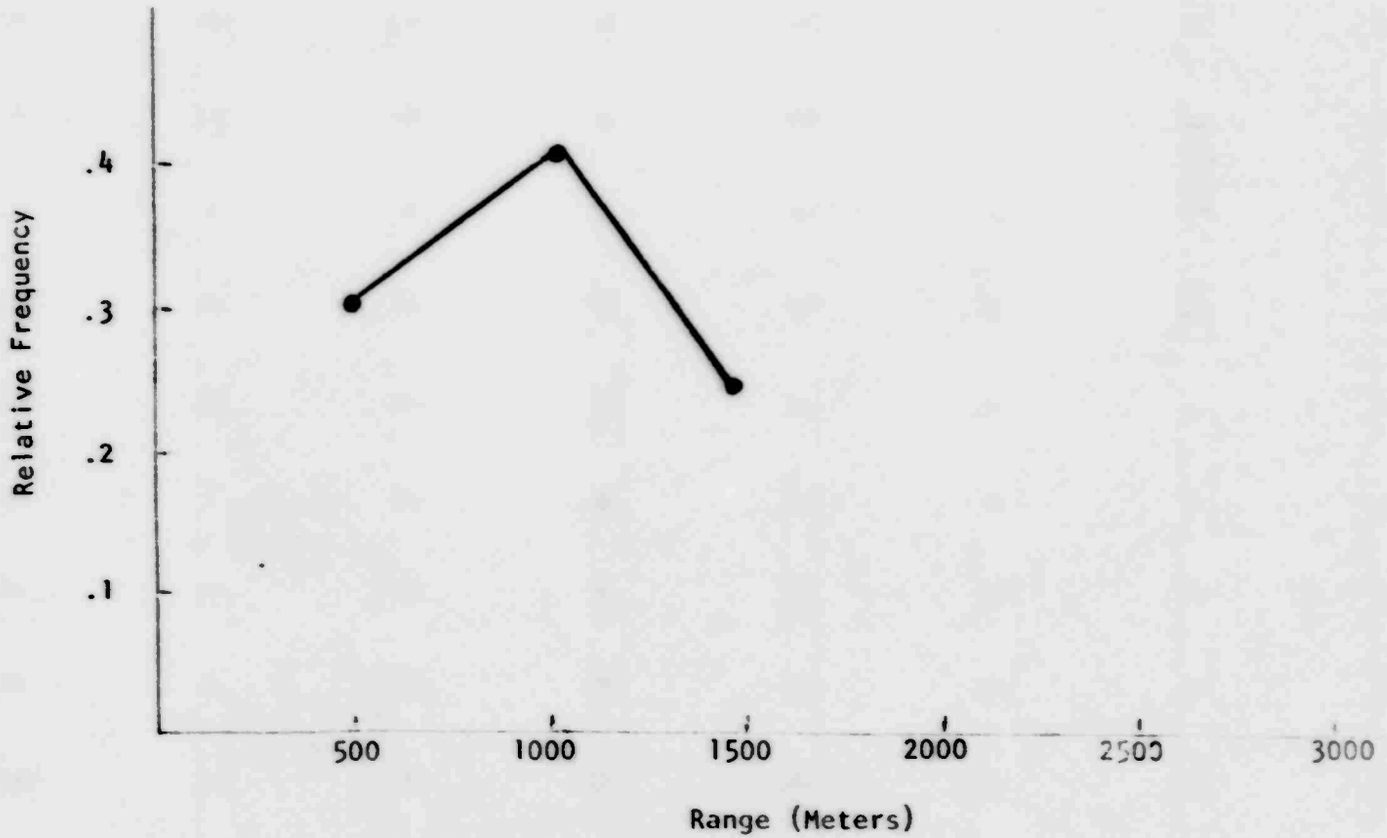

Figure 4. Distribution of ranges for Dragon engagements from TETAM data.

80% reduction in the number of targets visible; comparing mountainous to open terrain, there was a corresponding reduction of 50%. This study was based on the DYNTAC simulation model.

Implications for TOW and Dragon POI. The discussion above has identified some typical combat characteristics of ATGM engagements which could be applied to a threat oriented POI for TOW/Dragon gunners. These characteristics are summarized below:

- Multiple target approach paths should be present within a 30 degree arc from the firing position(s).
- Opening ranges should be about 2200 meters for the TOW and 1200 meters for the Dragon.
- Average engagement ranges should be about 1800 meters for the TOW and 800 meters for the Dragon.

If incorporated, these characteristics would be similar to that which could be expected in a mid-intensity conflict on typical FRG terrain.

The recommended performance measures are:

- Time to initial acquisition;
- Time to subsequent acquisitions;
- Tracking accuracy;
- Number of kills.

LINE-OF-SIGHT SEGMENTS

Although the hit probability of an ATGM is relatively constant (i.e., independent of range) under ideal firing conditions, such conditions are rarely found in combat especially in the FRG where terrain tends to be cluttered and undulating. In the Fulda Gap, land forms tend to limit intervisibility between gunner and target. Near Hohenfels and on the North German Plain, vegetation tends to be a limiting factor.[7] Consequently, the

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7 op. cit. Clark, et. al.

length of time the target is in view is curtailed. This time is dependent on the length of the line-of-sight (LOS) segment and the target's speed.

Gunner proficiency is directly related to the gunner's ability to select LOS segments of sufficient length to permit successful engagement, since the target must be tracked during missile flight time. Targets can pass out of view momentarily and be reacquired in time to achieve a hit, but this is the exception rather than the rule. Hence, gunners must be trained to acquire targets, predict movement direction, and select firing times which will maximize the probability of a kill. This requires skill on the part of the gunner since combat targets can be expected to move in a manner which minimizes vulnerability. As mentioned above, the use of smoke alone decreases target acquisition by 80%.[8] These factors reinforce the importance of training gunners under quasi-combat conditions.

Figure 5 shows the probability of a TOW-engaged target as a function of segment length. A segment length of 600 meters or more virtually insures engagement. At less than 200 meters, the probability of engagement is .2.[9] These data were gathered from 30 ridge-line positions at HLMR on 16 target approach paths. Similar data from FRG are not available.

Finally, it is necessary to know how often a particular segment length will occur. These data are shown in Figure 6 for the 1000 to 2000 meter range interval. Note that the very desirable 600 meter (or greater) segment length occurs less than 10% of the time. Although not shown in the graph, for ranges from 2000 to 3000 meters, the corresponding 600 meter (or greater) segment length occurs less than 5% of the time. Consequently, the gunner must work with shorter, less desirable in-view times for most engagements. Although similar data for the FRG are not available, existing reports indicate that segment lengths are generally shorter there.

Estimating threat movement speeds from existing literature is a difficult task. Although road speeds can exceed 35 MPH, the best estimate of cross country speeds is 15-20 MPH.[10] Threat movement rates are also

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8 op. cit. Barfoot, et. al.

9 op. cit. Clark, et. al.

10 Caviness, J. A., Maxey, J. L., and McPherson, J. H. Target detection and range estimation (TR-72-34). Alexandria, Virginia: Human Resources Research Organization, November 1972.

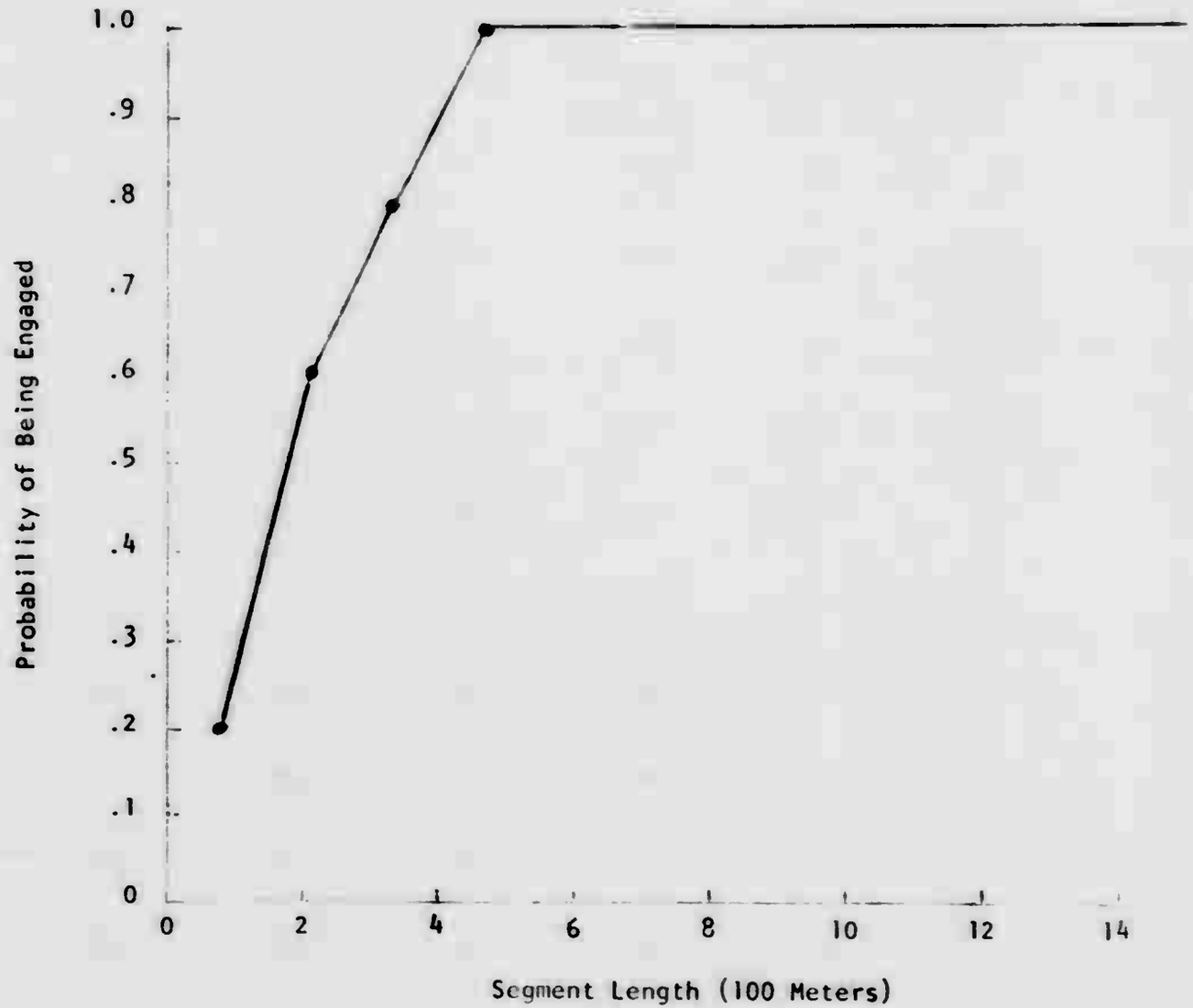


Figure 5. The probability that a threat vehicle will be engaged by TOW as a function of segment length (initial engagements only).

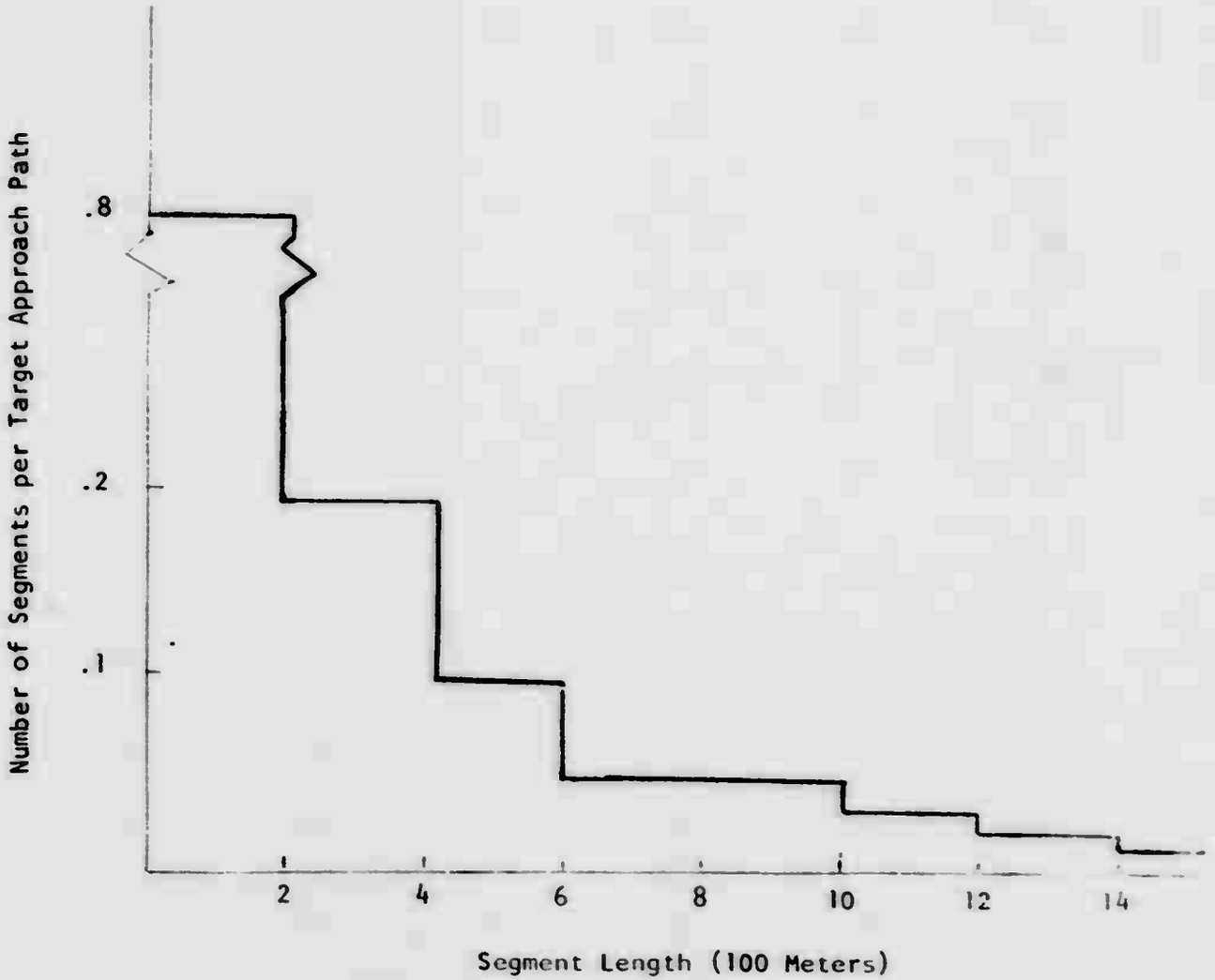


Figure 6. Segment length occurrence distributions for HLMR intervisibilty data for ranges from 1000 to 2000 meters.

available from the TETAMS - Extended Analysis data. They are based on the two tactics of rapid approach and fire and movement. Velocities were sampled at one minute intervals. For the rapid approach, targets moved at 4 to 5 meters per second (8-11 MPH) with an approximately normal distribution of velocities. During fire and movement, speed was similar but the variance of the observed distribution was larger in that about 70% of the targets moved between 2 and 7 meters per second.

Impact of LOS and Target Speed on Training. From the data given it is possible to develop a set of characteristics which would aid in training and testing a gunner under tactical conditions using a realistic set of line of sight segments and target speeds. Given six targets and six approach paths layed out under the conditions described in the previous subsection, each path should have 2 or 3 LOS segments varying in length from 200 to 500 meters (200-400 for Dragon, 300-500 for TOW). This should result in at least three targets being in view at any given time. From this selection of targets, the gunner must choose the highest priority target consistent with the best (longest) LOS segment.

The desirability of each LOS segment/target speed combination might be rank-ordered and the gunner's choices of targets, as the training scenario was played, might be used as an additional performance measure.

TARGET SELECTION

If more than a single target is available to the ATGM, there will normally be one or more characteristics of that target that will cause it to be more of a threat either to the ATGM itself or to its mission (e.g., defend a road junction). As mentioned in the preceeding section, range (target distance) is one factor. Since the hit probability of an ATGM is relatively independent of range and since a tank's main armament improves significantly with decreasing range, the ATGM becomes more vulnerable as the target approaches. Further, the probability of being detected by the enemy increases. Consequently, high priority targets (those representing the greatest threat) should be selected and engaged first, if LOS segments permit, preferrably at the extreme range of the TOW or Dragon.

An analysis of TETAMS data shows that a typical gunner has 5.7 targets in view at any one time (tanks, ATGMs, APCs, trucks). The targets can be divided into three types: high priority, (tanks, ATGMs), low priority (APCs, trucks), and previously killed targets. With reference to target selection, TETAMS had two pertinent findings:

- There is a strong tendency for gunners to shift to previously killed targets especially if the target has been killed within the preceeding 60 seconds;

- Gunners do not appear to select targets by range, but exhibit a small preference for targets which were previously visible.

These results were gained from data from highly trained gunners in a two sided simulated battle. It would be safe to assume that similar problems could occur in combat with less experienced gunners. More realistic training could improve the gunner's ability to assess the immediate threat by providing a set of selection criteria and the practice necessary to employ the criteria.

Implications for TOW and Dragon POI. The training environment should provide some of the complexities of the real world with respect to target types and the gunner's selection process. Targets which present different aural and visual cues and which represent different threat vehicles should become part of the POI. The conditions should include:

- Multiple targets - several targets moving simultaneously;

- Target types - high priority, low priority, and previously killed targets.

Gunner performance assessment should be based on the selection order and the degree of deviation from the optimum order as determined by the POI designers. The recommended performance measure is the order of target acquisition.

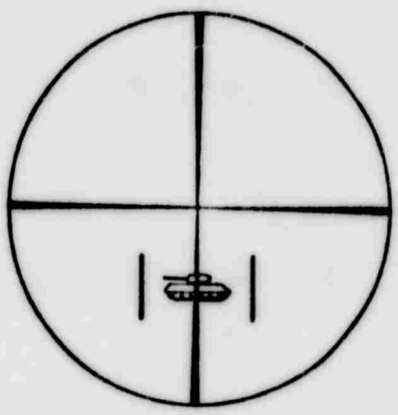
RANGE ESTIMATION

Unlike conventional antitank weapons, the need to accurately estimate target distances is less important for ATGM weapons. Hit probability remains relatively constant within the weapon's maximum effective range. However, it is extremely important for the gunner to insure that the target distance is between the minimum and maximum ranges of the weapon. For the Dragon the range must be between 65 and 1500 meters and for the TOW between 65 and 3000 meters. The near extremes represent missile capture times or the time the missile travels before the gunner can recover from launch and begin a steady tracking of the target. The far extreme is limited by the guidance system and propellant of the missile.

The table below shows the average and median range estimation errors for antitank gunners to 300 meters.[11] At 1000 meters, the range estimation error is 220 meters. Extending these figures to the maximum range of the TOW, it is probable that range estimation errors would exceed 300 meters. If a gunner attempts to engage a target which he believes to be within 1500 meters with Dragon and the target is actually at 1800 meters, the firing mission will fail. Further, there is a significantly high probability ($\cong .3$) that the launch signature will be detected by the enemy who in turn will attempt to neutralize the ATGM position by return or over-watching fire.[12] Consequently, the ATGM may have to move to an alternate position which essentially takes it out of the battle for some period of time allowing the enemy sufficient time to close the range thus increasing the capability of the enemy's main armament. Thus, it is imperative that the target be within reach but kept at long ranges.

RANGE	AVERAGE	MEDIAN
100	38	25
200	69.9	50
300	77.7	50

Current practice requires the gunner to establish in his mind the range to the target. For the Dragon the sight reticle can be used to determine whether a target is within the maximum range as shown in the following diagram.



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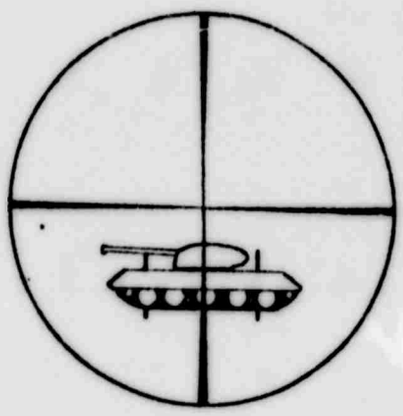

IN RANGE

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11 ibid.

12 op. cit. Clark, et. al.

The reticle is designed for a target 20 feet in length. The gunner must compensate for larger or smaller targets and for frontal and three-quarter side views. For the TOW, no such aid is provided. The entire process must be done without other aids, and current range estimating techniques depend heavily on the individual capabilities of the gunner.[13]

Implications of New Range Estimation Techniques on Training. In the past a range card has been used to aid the gunner in the range estimation process. A sample range card appears in Figure 7. This technique is no longer employed since current training emphasizes only the tracking process. When used, the range card is completed at each new weapon position. After selecting the position, the gunners use terrain features and range measurement devices, if available, to pinpoint imaginary demarkation lines. These fix some ground reference points of minimum, maximum and intermediate ranges. A scoring procedure for the completed range card would provide additional measures of performance:

- Adequacy of scope of the range score card.
- Accuracy of the range score card.

EVASIVE TACTICS

Very little field experimentation has been done to date on the effects of target evasive action on TOW/Dragon performance although field work is currently planned at USACDEC.[14] The types of maneuvers include swerves, fast turns, and random serpentine turns. Although these maneuvers could impact on the ATGM performance in terms of decreased hit probability, there is a countereffect, assuming cover is available. Any deviation from a straight line, high speed rush across an area prolongs target in-view time, thus vulnerability. Since there is a trade-off (impact not yet

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Swezey, R. W., Chitwood, T. E., Jr., Easley, D. L., and Waite, B. J. Implications for TOW gunnery training development (Final report, contract number DAAG 39-77-C-044). Springfield, Virginia: Mellonics Systems Development Division of Litton Systems, Inc., October 1977.

14

U. S. Army Combat Developments Experimentation Command. Antitank missile test (ATMT). Fort Ord, California: Author, April 1976. (AD-B010 576L)

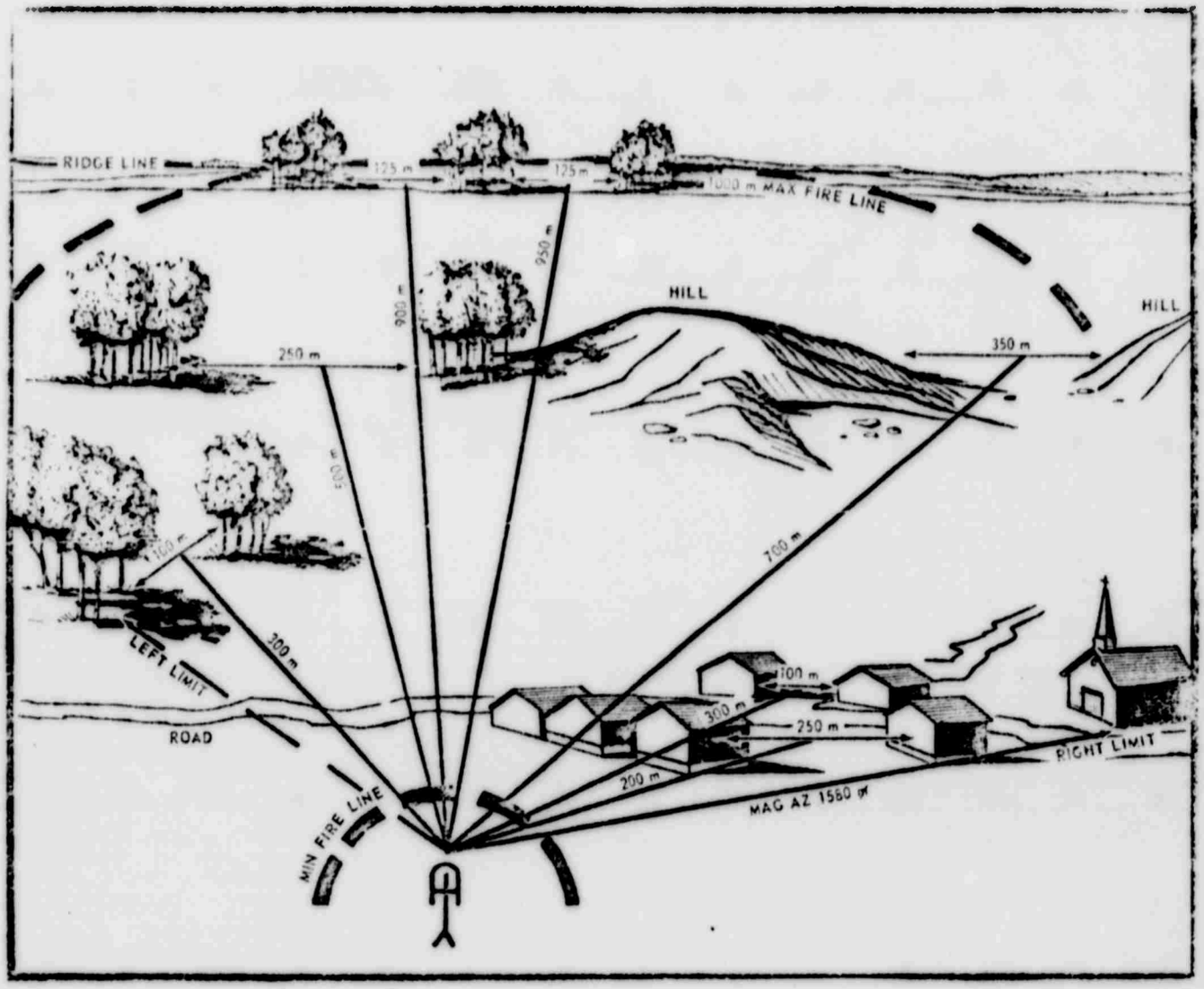

Figure 7. Dragon range card.

known) the implementation of evasive maneuvers should be postponed until findings are available from the planned field experiment.

CONCLUDING COMMENTS

There are other factors which ought to be considered which were not included in this review. These factors include target hand-off, movement to alternate positions, and the addition of noise and obscuration. Such factors should be considered as attempts are made to add realism to the TOW and Dragon POI. In the USACDEC TETAM experiments, target hand-off (the transferring of a given target to another weapon position) was found to be a complex task which could consume inordinate amounts of time at critical moments during the battle. This problem should be studied to establish the value of this action, and if found effective, should be addressed in the training program.

TOW and Dragon signatures can compromise the defensive position inviting return fire from the targets or their supporting alternate positions. But time can be lost at critical periods of the battle. Consequently, such movement must be done quickly and efficiently. Routes must be selected and weapons must be disassembled and reassembled under the most adverse conditions. This is an area that should be addressed during training.

The very critical and delicate task of tracking (guiding the missile) may be interrupted by momentary distractions caused by incoming rounds or muzzle noise from nearby friendly weapons. The success of the firing mission depends on prior actions and decisions, but at this point of the engagement process much depends on the gunner's ability to stay on target. The addition of such distractions (e.g., using oxygen-propane artillery simulators) may prepare the gunner to become habituated to startling stimuli.

SUMMARY AND RECOMMENDATIONS

The thrust of this paper has been to examine techniques and procedures for increasing the degree of combat reference in TOW and Dragon training POI. General Marshall noted, "Training effectiveness is observed on the battlefield where it is too late to remedy deficiencies. When training is superficial, lacking in relevance and imagination, troops will not regard the fighting value of their weapons highly. They will be slow to give an understanding of how their weapons should be used".[15] Training should focus on increasing the soldier's ability and willingness to use weapons rather than on the weapon's killing power.[16]

The weakness in current TOW and Dragon POI is that combat relevance is lacking. Training focuses on setting up the weapon and tracking targets, hence, it skips the very important decisions that should take place between these two actions. Missing are the important functions of finding targets and assessing their characteristics vis-a-vis the capabilities of the weapons. Should we engage? Can we engage? Is engagement of this type of target consistent with our mission? Where along the approach path is the best place to engage? What do we do after engagement if we don't kill the target, or do kill the target? All of these steps require planning and preparation and will in combat impact on the gunner's willingness and effectiveness.

If we consider the vulnerability of the ground mounted system, planning, preparation, innovation and skill become even more important. To use the extremely long firing range of the weapons (3000 meters for the TOW), a commanding position on the terrain is usually necessary. It is likely that the enemy will focus suppressive fire, either from the targets themselves or artillery, on such likely weapon positions. Further, as the range to target decreases, the accuracy of a tank's main armament increases, along with the probability of the tank crew detecting the AT weapon position. Consequently, as the intervisibility range decreases the survivability of the ATGM also decreases. Hence, training should focus on those aspects that enhance ATGM performance: early detection, identification

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15 Marshall, S. L. A. Infantry operations and weapons usage in Korea, winter of 1950-51. Baltimore, Maryland: The John Hopkins University - Operations Research Office, 1951.

16 Jacobs T. O., Salter, M. S., and Christie, C. I. The effects on training requirements of the physical and performance characteristics of weapons (TR-74-10). Alexandria, Virginia: Human Resources Research Organization, June 1974. (AD-920 040L)

and optimum engagement procedures.

It is appropriate to move to the opposite extreme and ask if realism can be carried too far. Training could be conducted under the grimmest possible conditions, in bad weather, with noise, smoke, and other disruption variables (suspense, surprise, pressure). However, the presence of these factors does not insure adequate training. HumRRO, while developing the TRAINFIRE concept, recommends, rather than using disruptive stimuli, an analysis of the precise nature of combat performance requirements, concentrating on relevance rather than realism.[17] The rationale being that realism in terms of adverse conditions could not be simulated adequately, but relevance could be included by extensively teaching combat performance requirements.[18]

The recommendations to achieve an increased degree of relevance based on this review are summarized below:

1. Several target types should be present to determine whether gunners can apply a system of priorities. Target types should include high priority (tanks, ATGMs), low priority (APCs, trucks), and previously killed targets;

2. Multiple target paths should be present within a 30 degree arc from the firing position(s);

3. Several targets should be moving simultaneously along paths with different line-of-sight segments (200-500 meters) in order to evaluate the gunners decision process;

4. Opening ranges should be about 2200 meters for the TOW and 1200 meters for the Dragon;

5. Average engagement ranges should be about 1800 meters for the TOW and 800 meters for the Dragon;

6. Target movement speeds should be 4 to 5 meters per second (8-11 MPH);

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17 Hammes, J. A., Kelly, H. E., McFann, H. H., and Ward, J. S. TRAINFIRE II: A new course in basic technique of fire and squad tactics (TR-41). Washington, D. C.: Human Resources Research Office, July 1957.

18 McFann, H. H., Hammes, J. A., and Taylor, J. E. TRAINFIRE I: A new course in basic rifle marksmanship (TR-22). Washington, D. C.: Human Resources Research Office, October 1955.

7. Range cards should be completed at every firing position;

8. The use of evasive tactics should not be considered until field tests assessing their value have been completed;

9. The problem of target hand-off should be reviewed to determine the necessity for inclusion in the POI;

10. The need to provide distractions during tracking should be examined, perhaps through experimentation.

Corresponding measurement parameters for the above recommendations should be based on the descriptions below:

- Order of target/LOS selection;
- Time to initial acquisition;
- Time to subsequent acquisitions;
- Tracking accuracy;
- Number of kills;
- Adequacy of range card;
- Accuracy of range card.

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